

Coopers – Co-operative Systems for Intelligent Road Safety



Project 026814



COOPERS -

Co-operative systems for intelligent road safety

**Analysis and Validation:
Communications, HMI and
Test Bench – first results**

E. Schoitsch, T. Gruber, E.
Althammer (AIT), S. Fuchs
(Brimatech)



European Commission
Information Society and Media

Co-funded by the EC, FP6 IST-Programme





Project facts

COOPERS – Co-operative Systems for Intelligent Road Safety

- Integrated Project of 6th Framework Programme
- Coordinator: Austria Tech
- Total budget: € 16.8 Million
- EC contribution: € 9.6 Million
- Consortium: 37 partners - 14 countries
- Start on 1. February 2006
- Duration 54 months, extended towards July 2010

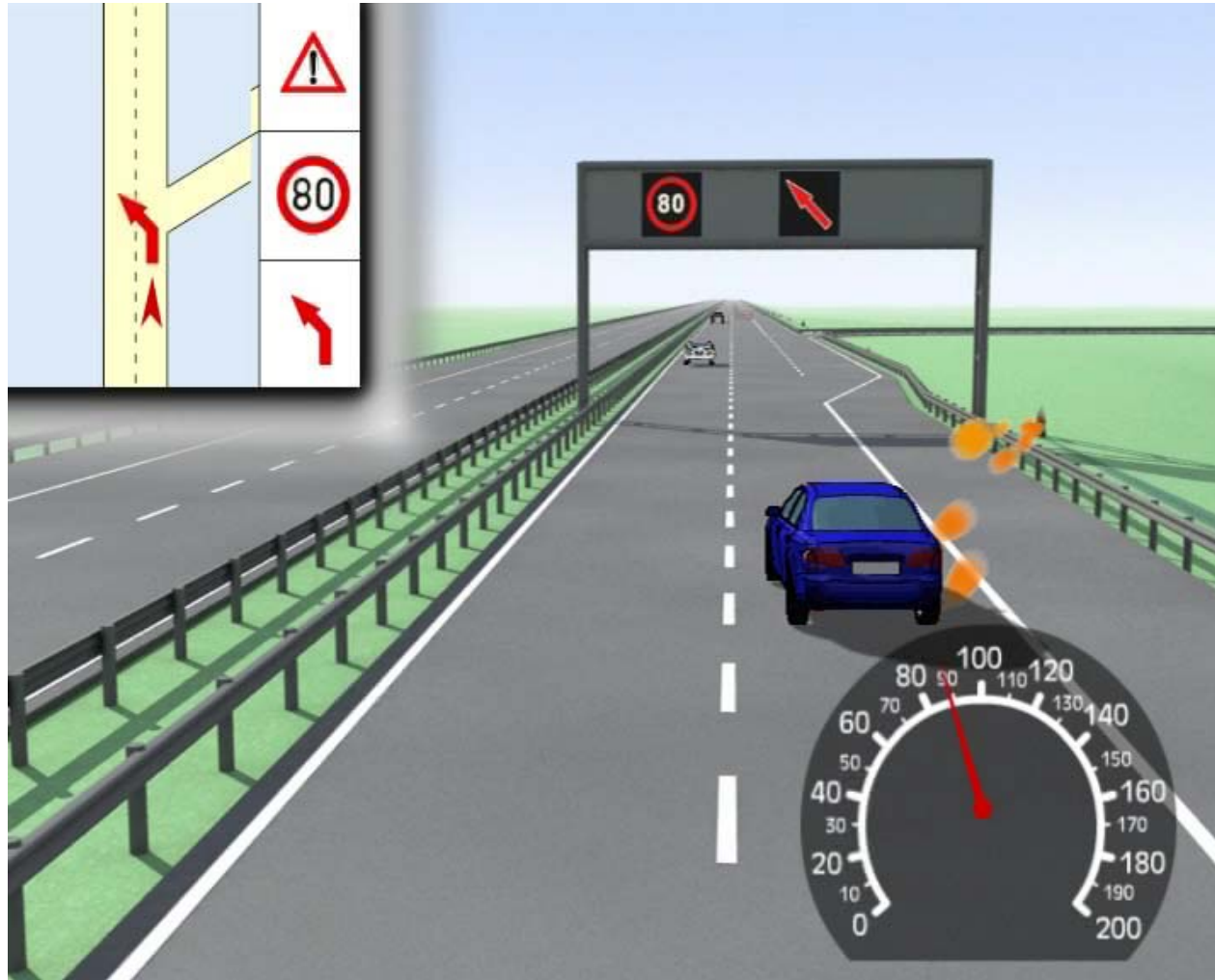


Areas of work in COOPERS

- Development of safety related services using V2I communication from a traffic management (road operator) perspective
 - Roadside data acquisition
 - Traffic control centre applications
 - Infrastructure to vehicle communication
 - On-board Unit / HMI
- Investigation of driver behaviour due to additional traffic information
 - Identification of test methodology
 - Test drives (also driving simulator)
 - Analysis



COOPERS Vision (Drivers View)





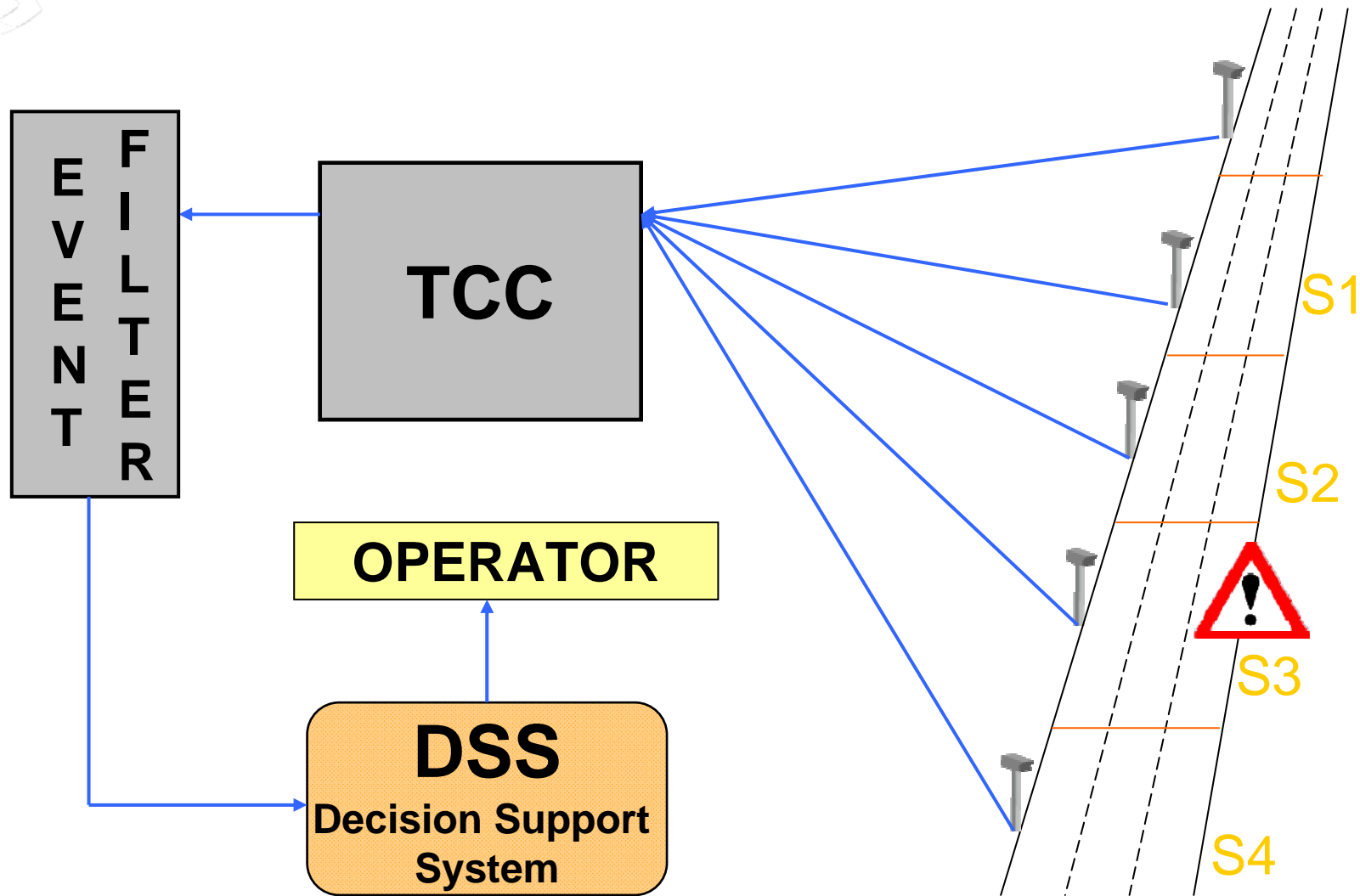
COOPERS Services



- S1: Accident/incident warning
- S2: Weather condition warning
- S3: Roadworks information
- S4: Lane utilization information
- S5: In-vehicle variable speed limit information
- S6: Traffic congestion warning
- S7: ISA with links to infrastructure
- S8: International service handover (or continuity)
- S9: Road charging to influence demand
- S10: Route navigation – estimating journey time
- S11: Route navigation – recommending next link
- S12: Route navigation - automatic road map update
- S13: Floating Car Data

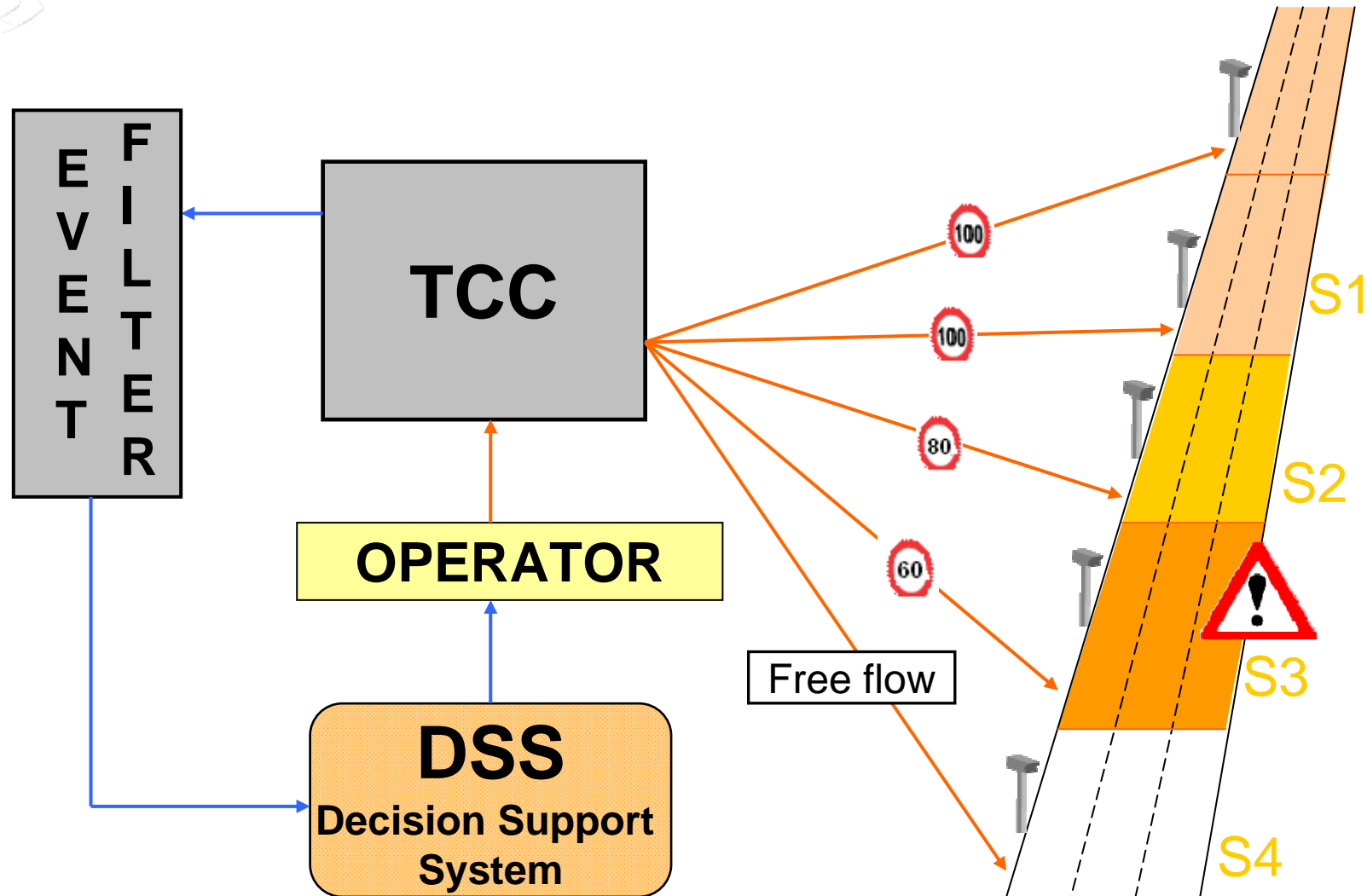


Communication Flow





Communication Flow





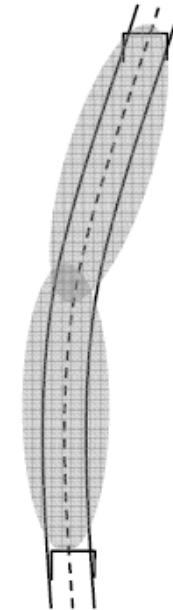
Traffic Scenario #1

High Traffic Density at weekends

- Maximum segment length 2 km
- Car length + distance to next appr. 7,5 m
- Maximum number of lanes 5

= Max. 1400 Cars / Segment / Direction

= Max. 2800 Cars / Segment



2 sectored cells

Limiting factor:

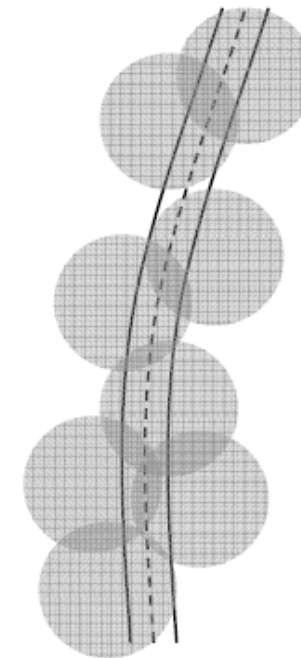
Performance at High
traffic density



Traffic scenario #2

High Cruising Speed

- Minimum segment length 800 m
- Maximum speed 180 km/h
- Minimum retention time per segment 16 sec



Omni cells

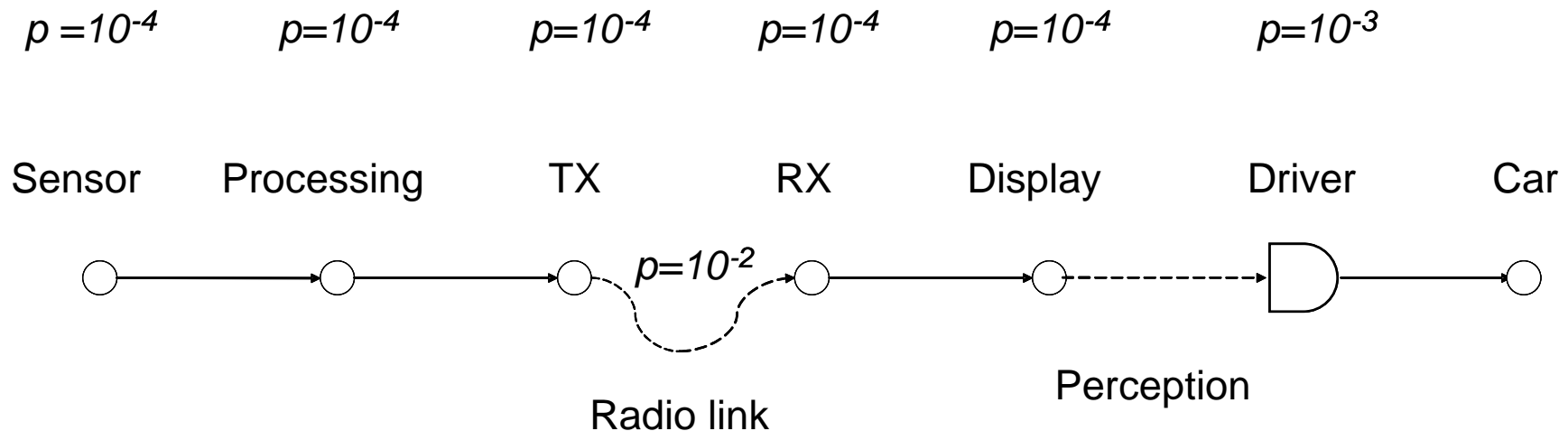
Limiting factor:

Handover at high speed



RAMSS Analysis for Coopers

- Preliminary Hazard Analysis (PHA)
- Hazard and Operability Analysis (HAZOP) performed
- Holistic Approach includes all objects/subjects in signal path



- *Signal flow path & coarse failure rate estimation (per information transfer)*
- Car out of scope – no contribution to loss of safety gain



Results and Recommendations

- **Two bottlenecks in reliability**
 - *Radio link* → $p \cong 10^{-2}$
 - *Driver* → $p \cong 10^{-3}$

- **Recommendations**
 - Services tolerant against communication failures
 - ***Take special care of user interaction and HMI***
 - Avoid directly controlling the car – otherwise SIL > 0



COOPERS Communication Media

❖ Broadcast Media

❖ DAB (Digital Audio Broadcast)

❖ DVB-H (Digital Video Broadcast Handheld)

❖ Cellular Communication Media

❖ GPRS (2.5G Cellular Networks)

❖ WiMAX (Metropolitan Area Networks)

❖ Short-range Communication media

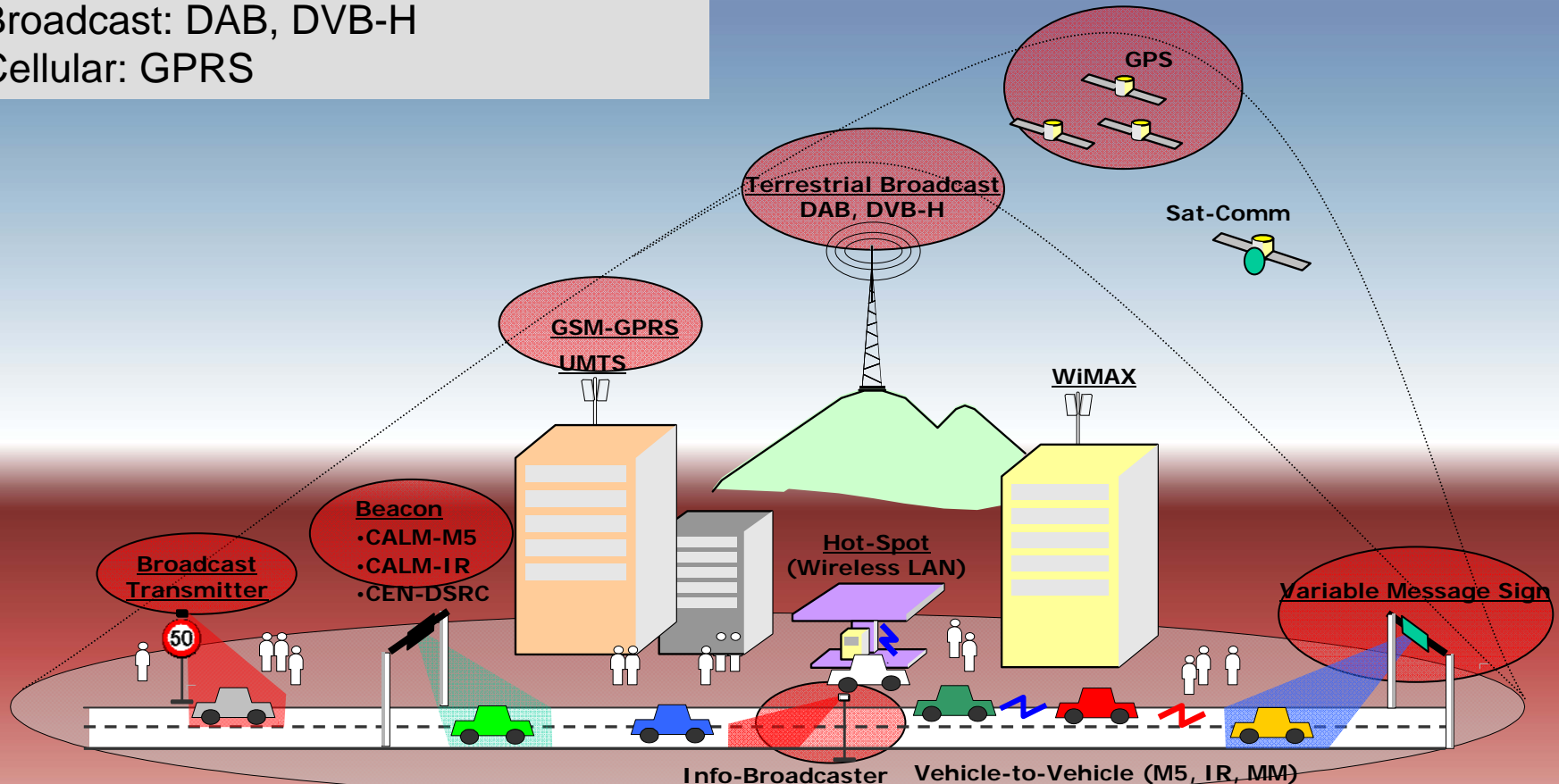
❖ Infrared (CALM IR)

❖ *Microwave* (5.9GHz)

COOPERS Communications

The COOPERS Communication Media

- Mid Range: CALM-Infrared, (CALM-M5 not in COOPERS)
- Broadcast: DAB, DVB-H
- Cellular: GPRS



The “CALM-World”

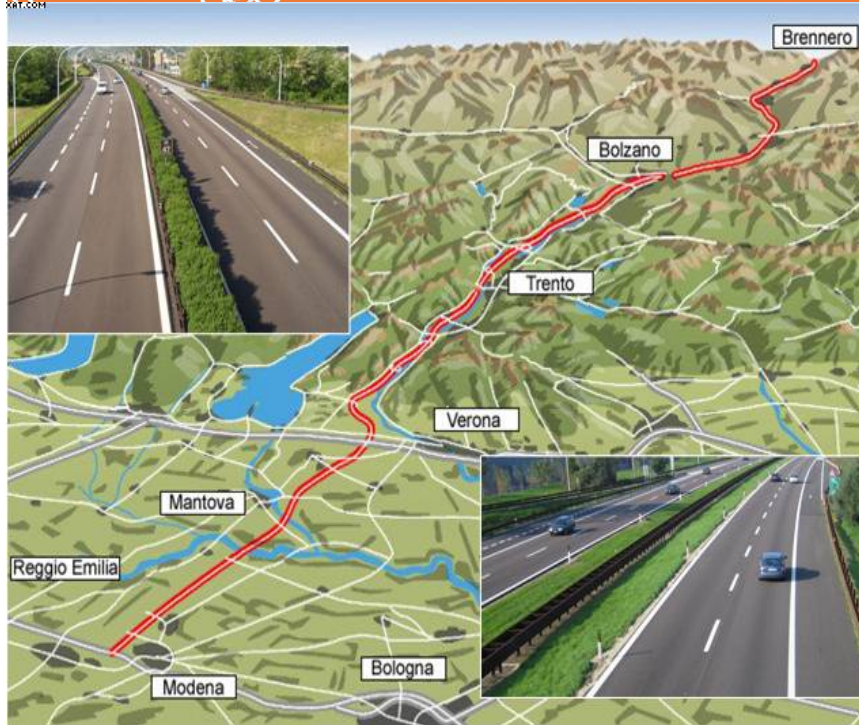
Combining existing technologies like Cellular and new media like WAVE and CALM-IR, and adding required networking and management capabilities

Selected communication technologies

COMM-Technologies selected for COOPERS:

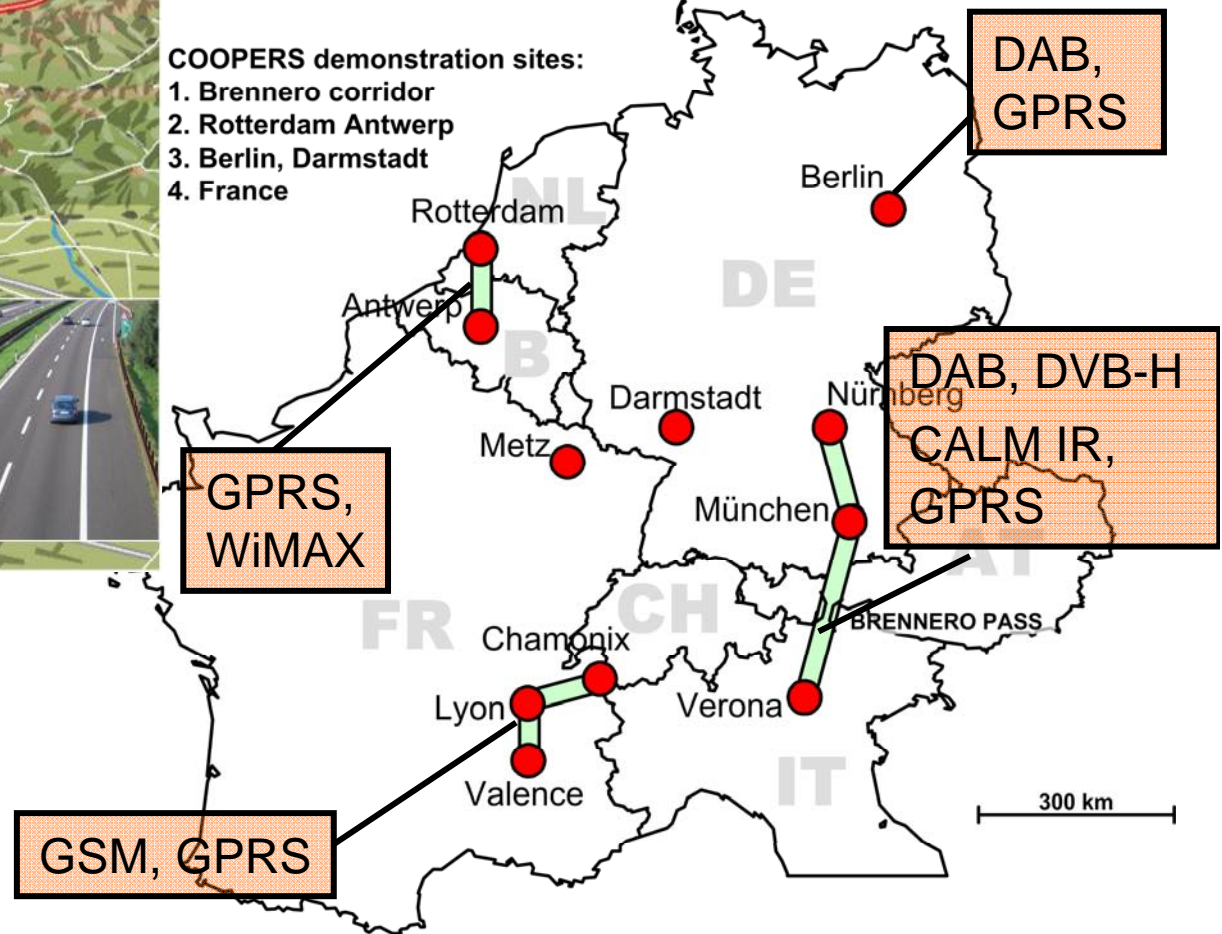
- Medium / Long Range: **GSM/GPRS** (because of widely deployed infrastructure). Availability 1Q 2008.
- Long Range: **DAB** (because of the effective way to deliver messages in a wide area). **DVB-H** will be investigated as alternative to DAB as far as possible
- Short / Medium Range: **CALM-IR** (because it can share the CEN-DSRC Road Charging infrastructure with without interfering). Availability 1Q 2008. In a later stage, **CALM-M5** (“WLAN”) will complement CALM-IR once M5 has stable means to protect the tolling – (not in COOPERS)

COOPERS - Test sites



COOPERS demonstration sites:

1. Brennero corridor
2. Rotterdam Antwerp
3. Berlin, Darmstadt
4. France





Conclusions for Communication Media

Conclusions for standardisation:

- No single communication technology can cover all the requirements of traffic management (reliability) – a combination of two communication media is required
- Current status: combination of cell-based and short range medium best candidate, CALM protocol (standardization effort by COOPERS partners (AustriaTech and others) and ETSI)
- Demonstrations: about 400 km test runs, several weeks live operation with concept cars – these hypothesis confirmed

Cooperative systems will improve road safety !



Risks Related to the HMI

- Possible problems
 - Information delayed
 - Confusion through information overload
 - Visibility issues (direct sunlight, glare)
 - Misunderstanding displayed information (language, symbols, ...)
 - Lack of clarity, ambiguity (slow understanding process)
 - Non-intuitive interface (difficult handling)
 - Driver distraction (e.g. video playing)

→ All resulting in wrong driver reaction



HMI Requirements

- HMI working group established, series of phone conferences
 - Partners involved in the development work packages
 - 3 months duration
 - HW and SW requirements
- Goal
 - Avoid loss of safety gain
 - Improve user acceptance
- Basis
 - Experience of partners
 - Standard literature (Jacob Nielsen)
 - EU standards



EU Recommendations for In-car HMI

- Commission Recommendation of 22 Dec. 2006 on safe and efficient in-vehicle information and communication systems
 - Update of the European Statement of Principles on Human Machine Interface (1999)
 - How the service interaction with the driver shall be implemented
 - Suggested driver training
 - User as well as installation manuals issues



Examples for SW Requirements

- The system shall be configurable for the different languages of all countries where it is to be used. All standard messages shall be displayed in the configured language.
- Hazard warnings shall be issued starting at a distance of 2000 m. In addition to the warning sign the distance shall be displayed and updated continuously until the obstacle with a granularity of 50 m.
- The car PC shall allow configuring the hazard prioritization algorithm.
- Non-standard messages shall be distributed by the TCC at least in the local language and in English
- Coopers in-car HMI functions shall be compliant with usability requirements in EC recommendations of 22 Dec. 2006 and with IR 2400-1



Types of Displays

- graphics display integrated in the OBU
- graphics display
- external graphics display
- graphics head-up display integrated with windscreen
- alphanumeric display integrated in OBU

- Recommendation:
 - Graphics colour display



Visibility / Contrast in Sunlight & Night

Recommendations:

- Visibility/contrast very important issue!
- Special screens for in-car use, not standard VGA!
- Adaptive abilities for various light situations – today part of displays automatic dimming -> separate light sensor.
- Anti-reflex coating!



Source: Fraunhofer FIRST:

Numeric brightness values in a data sheet may be misleading
=> Experimental comparison of the brightness in direct sunlight!



Haptic Displays

Types:

- Actuator for haptic sensation, e.g. trembling steering wheel or seat
- mechanic reaction of HMI component like accelerator pedal reaction

Recommendations

- Haptic displays may distract the driver's attention because the reason of the haptic sensation is often not clear.
- Tremble may be misinterpreted as a technical defect (e.g. flat tire)
- => haptic displays are not recommended.



Keys/Keyboards

- touch screen
- hard keys
- remote control

Recommendations:

- yes/no decisions -> **hard buttons** as good as touch screens.
- more complex decisions -> **touch screens** recommended. (most Coopers services need not much input)
- remote control not very practical - may be displaced.



Location of Display

- integrated in dash board
- on top of dash board
- head-up display

Recommendation:

- any option ok
- it takes more time for accommodation to look down than to look aside. So a location **on top of the dashboard** is to be **preferred** to a lower location.



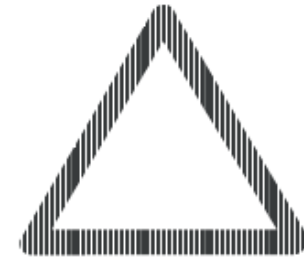
Symbols



A 4b



A 5



A^a

- **Vienna Convention on Traffic Signs of 1968**

- defines shape and content of traffic signs
- leaves some space for choosing between colour schemes



A 24



A 2b



A 2^a

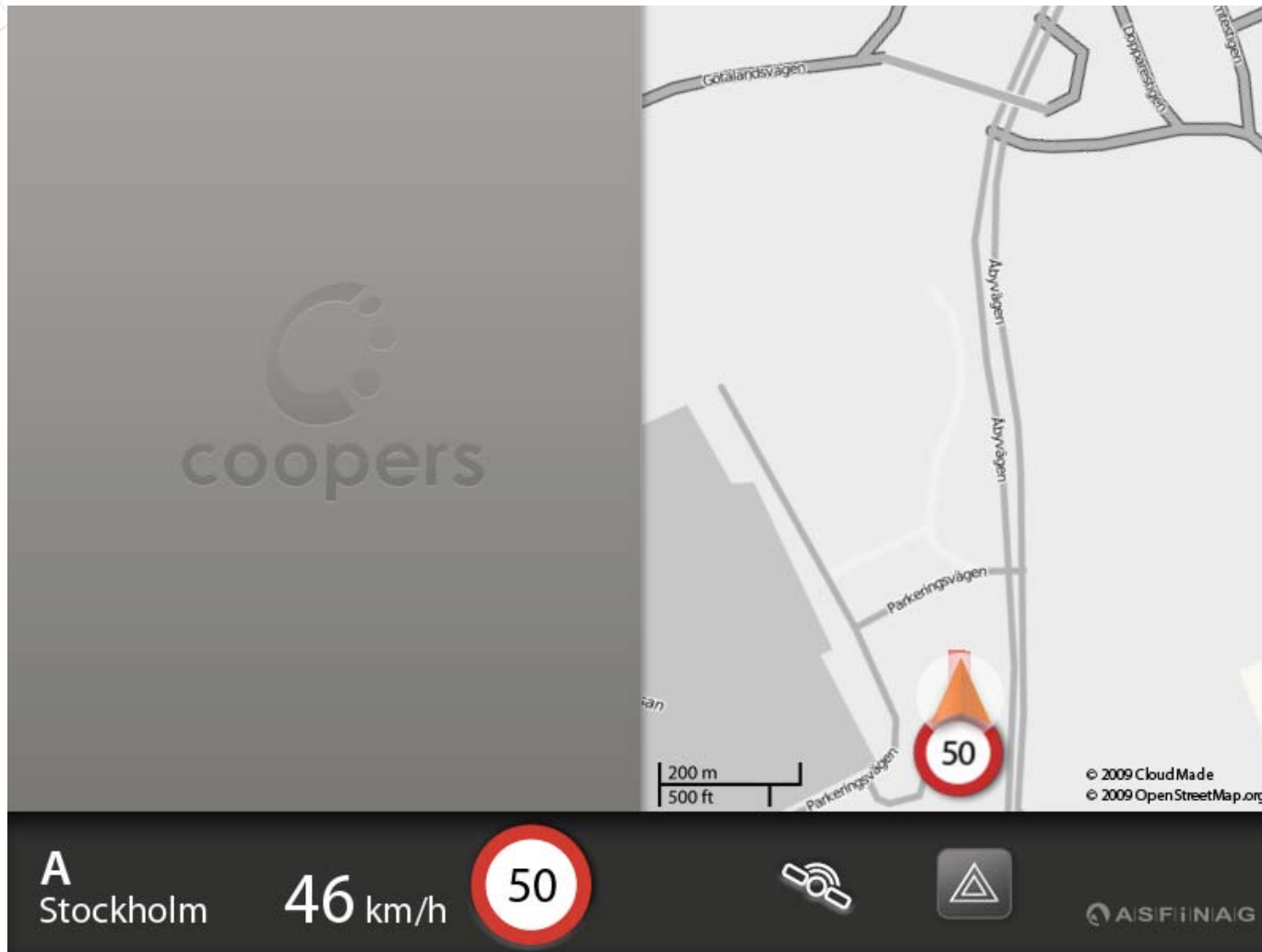
Recommendations:

- Symbols better than text
- Equal national traffic signs displayed on VMS (configure)
- Static symbols -> minimize driver distraction
- Animated symbols only for urgent messages
- If moving symbols -> movement must be meaningful.

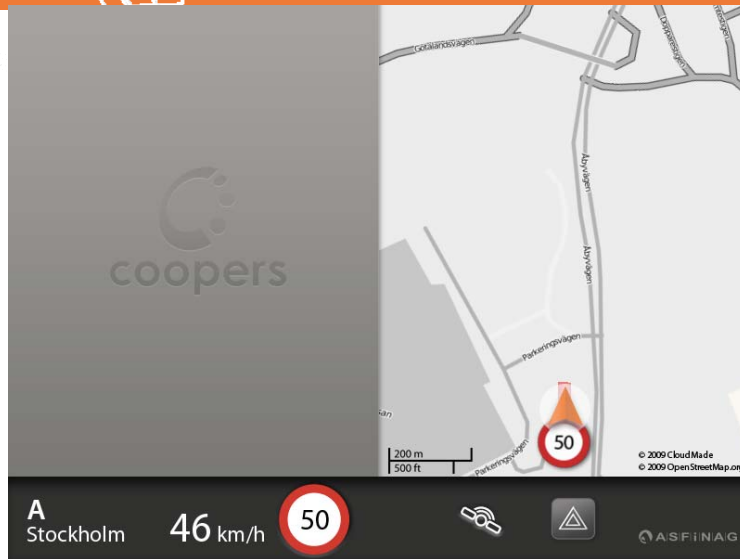


A 12^a

In-vehicle HMI, e.g Berlin site

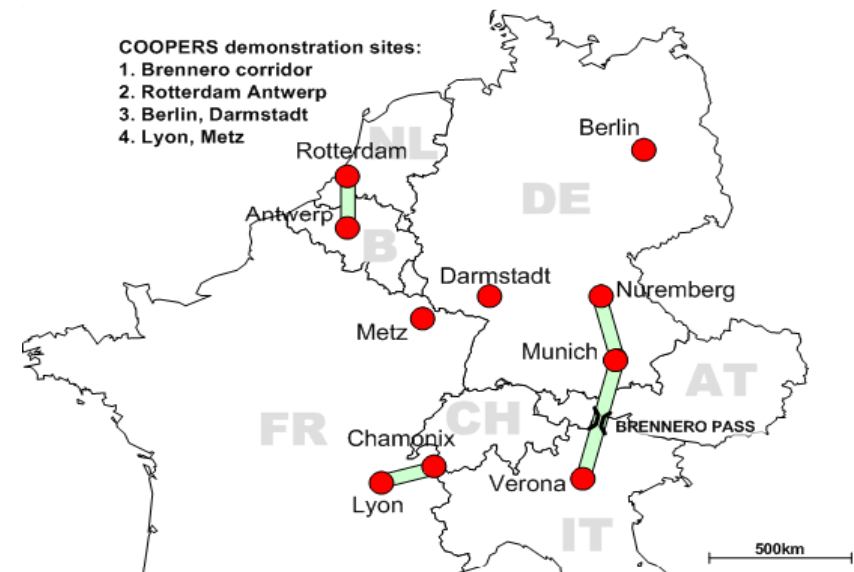


HMI: Summary and Conclusions

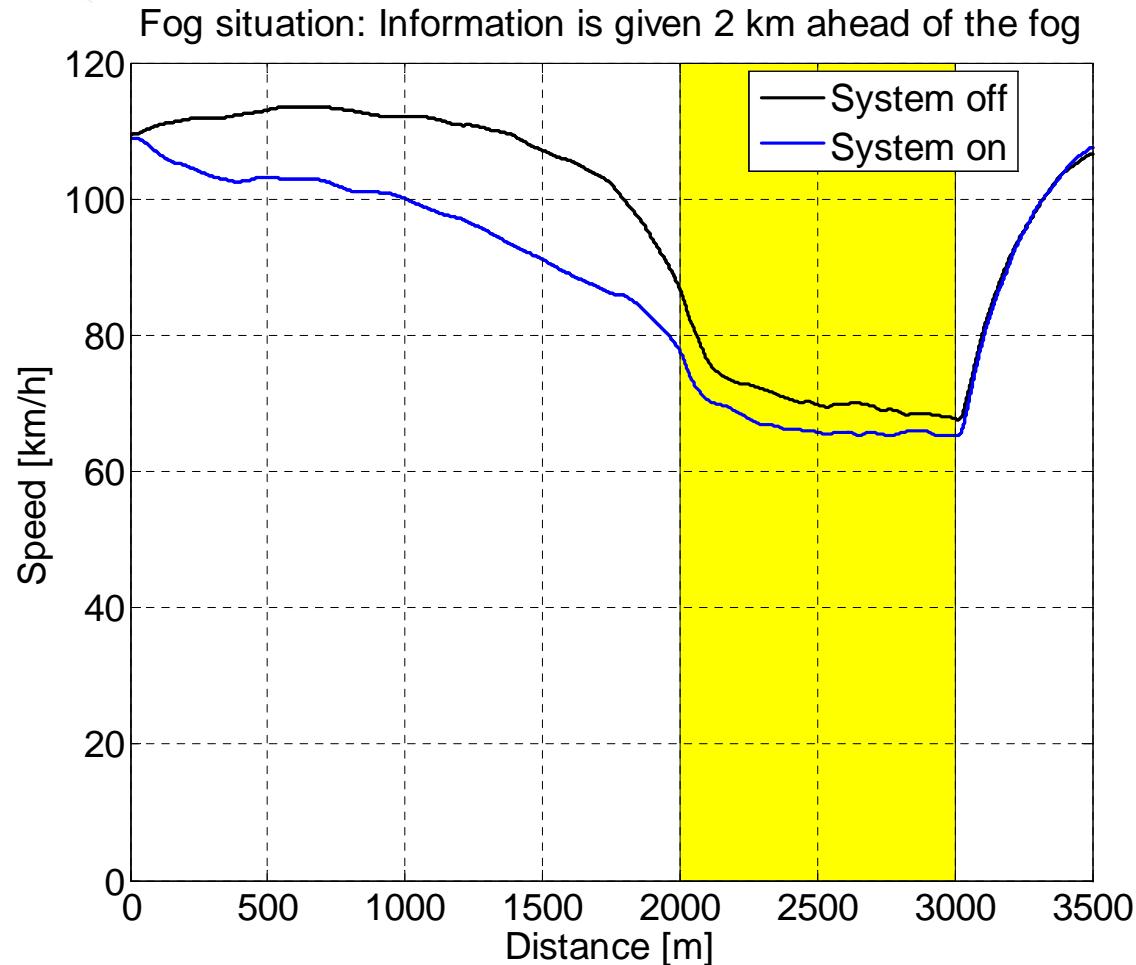


- Most of the HMI requirements implemented
- Some not exactly – Reasons:
 - **Propotypic demonstrator**
 - **Adapt existing products**
 - **Learn from first experience and simulations**

- Questionnaires for test drivers
 - Fill in before/after the drives
 - Evaluate feedback
- Simulations:
 - Positive feedback from drivers
- Currently demonstrations
- Next: Evaluation of results



Driving simulator results:



Driving simulator results

- Mean speed - Fog
- more than 90 % of drivers reacted to the warning
- reduced their driving speed by 14 %

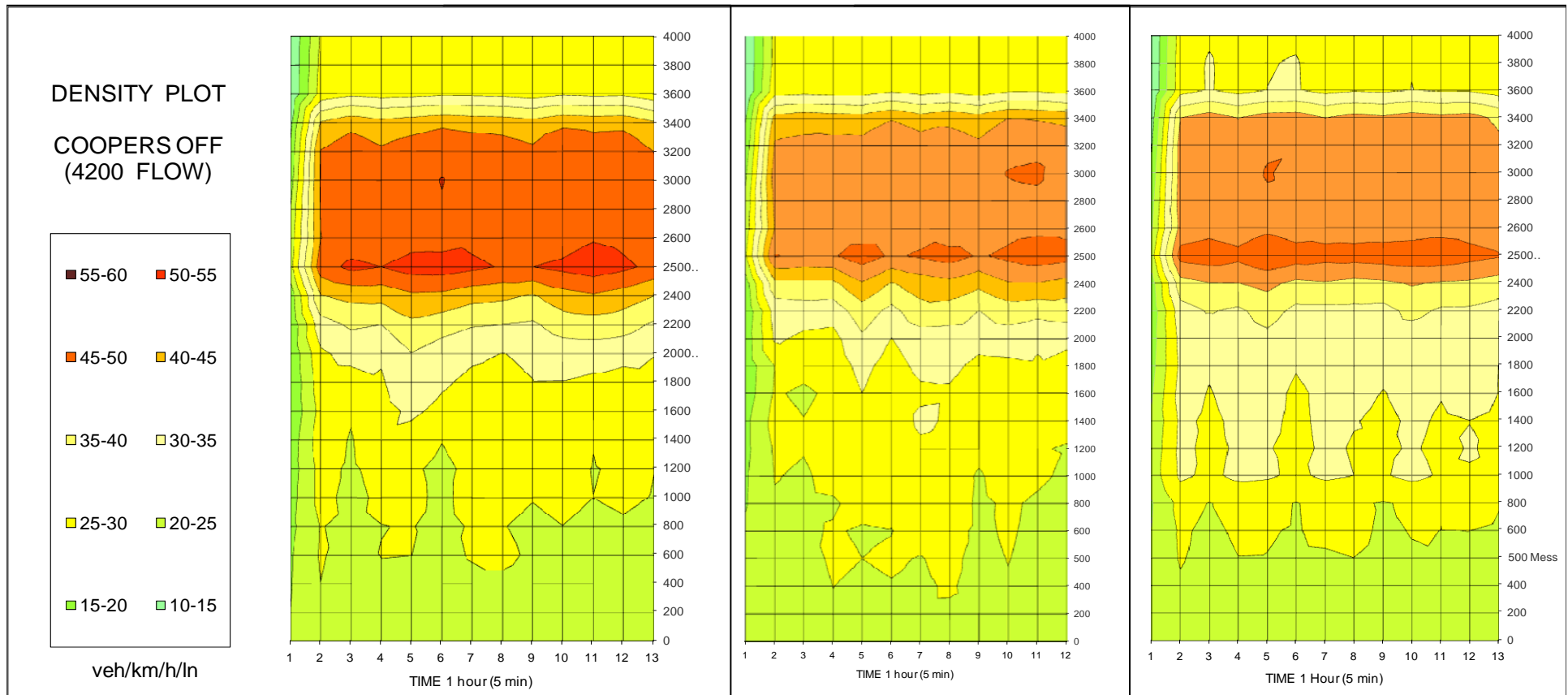


Traffic Simulation Results

Coopers off

Coopers off/on

Coopers on





Conclusions:

Conclusions:

- Expectations of drivers and operators can be met with cooperative systems
- Cooperative systems add the necessary direct communication link
- Driver understand and react to messages and adapt their driving
- Benefits, if traffic management information is integrated fully

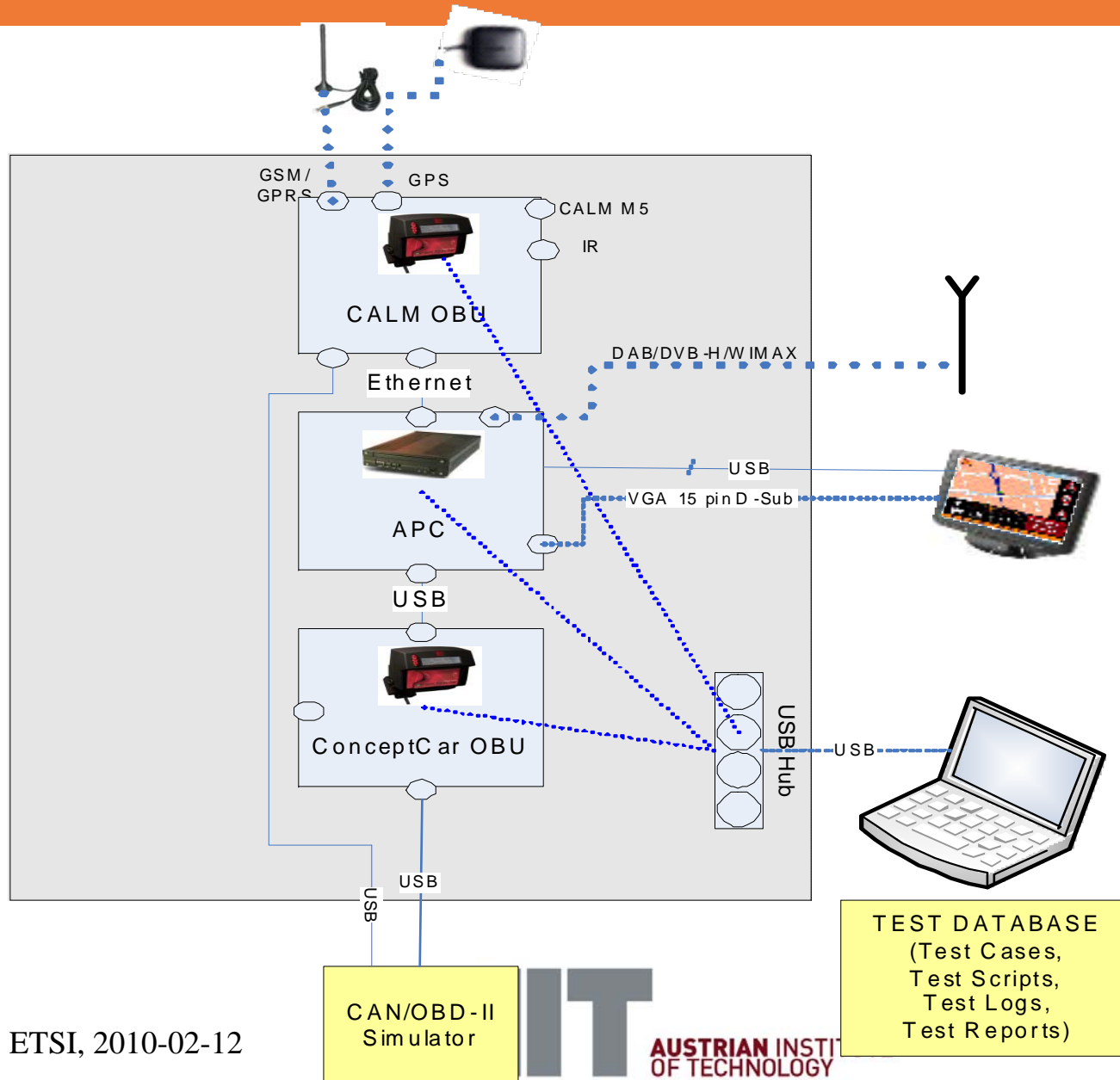


COOPERS Validation Activities

- WP 5000 (Validation) tasks:
 - Subsystem tests and overall system tests on all sites
 - Log file based measurement of key requirements
 - All services, all wireless technologies
 - Acceptance test = 3 consecutive successful drives
- Status test bench:
 - Ready since early 2009
- 2009: 2 acceptance tests performed
 - Cw 47: Site 1 / section Italy
 - Cw 48: Site 2 / NL-BE
- 2010: Site 1 / Section Austria (Brenner/Inn Valley)
 - In contact with ASFiNAG
 - Acceptance test done (January 2010), good results



COOPERS Test Bench



ETSI, 2010-02-12

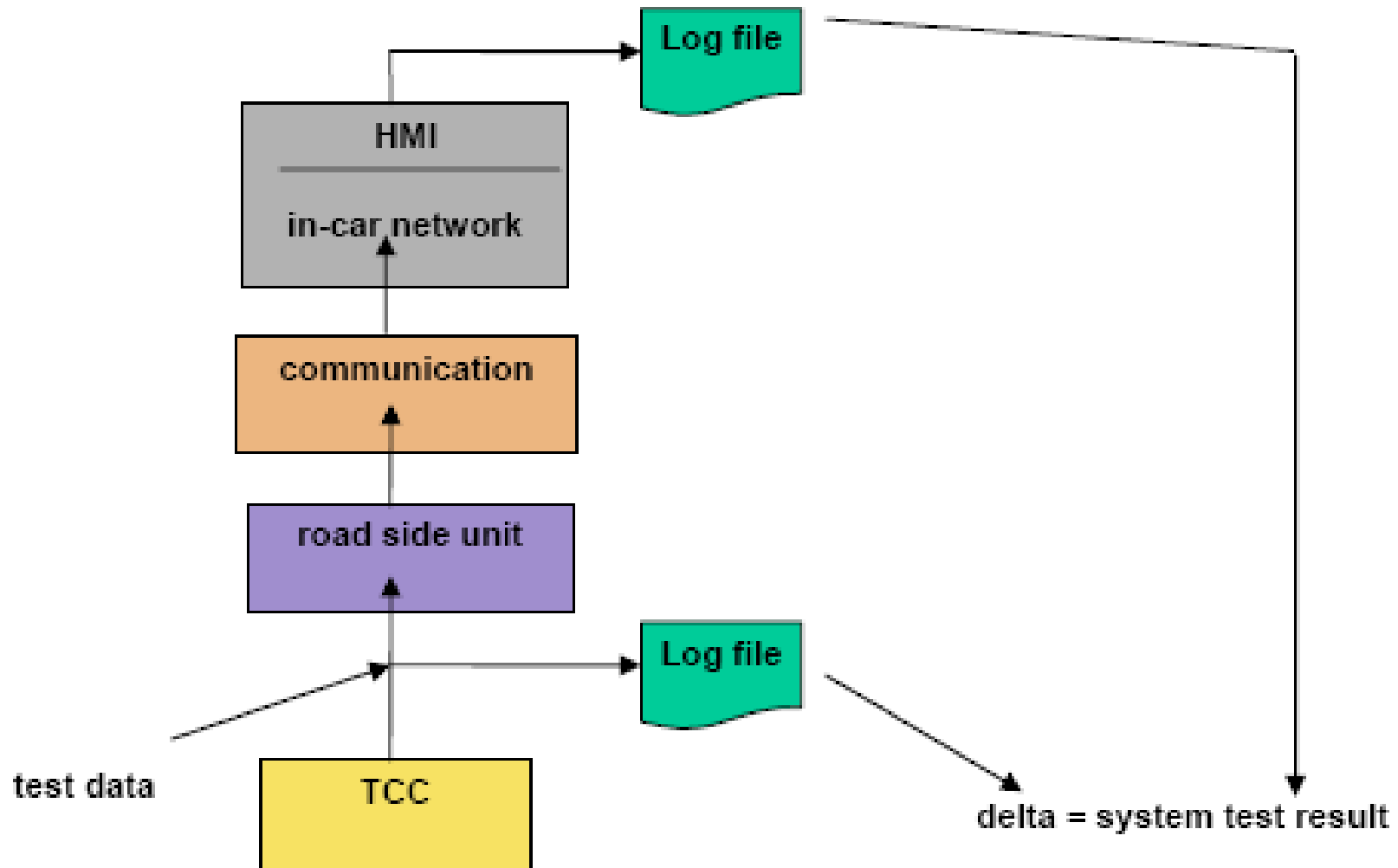
CAN/OBD-II
Simulator



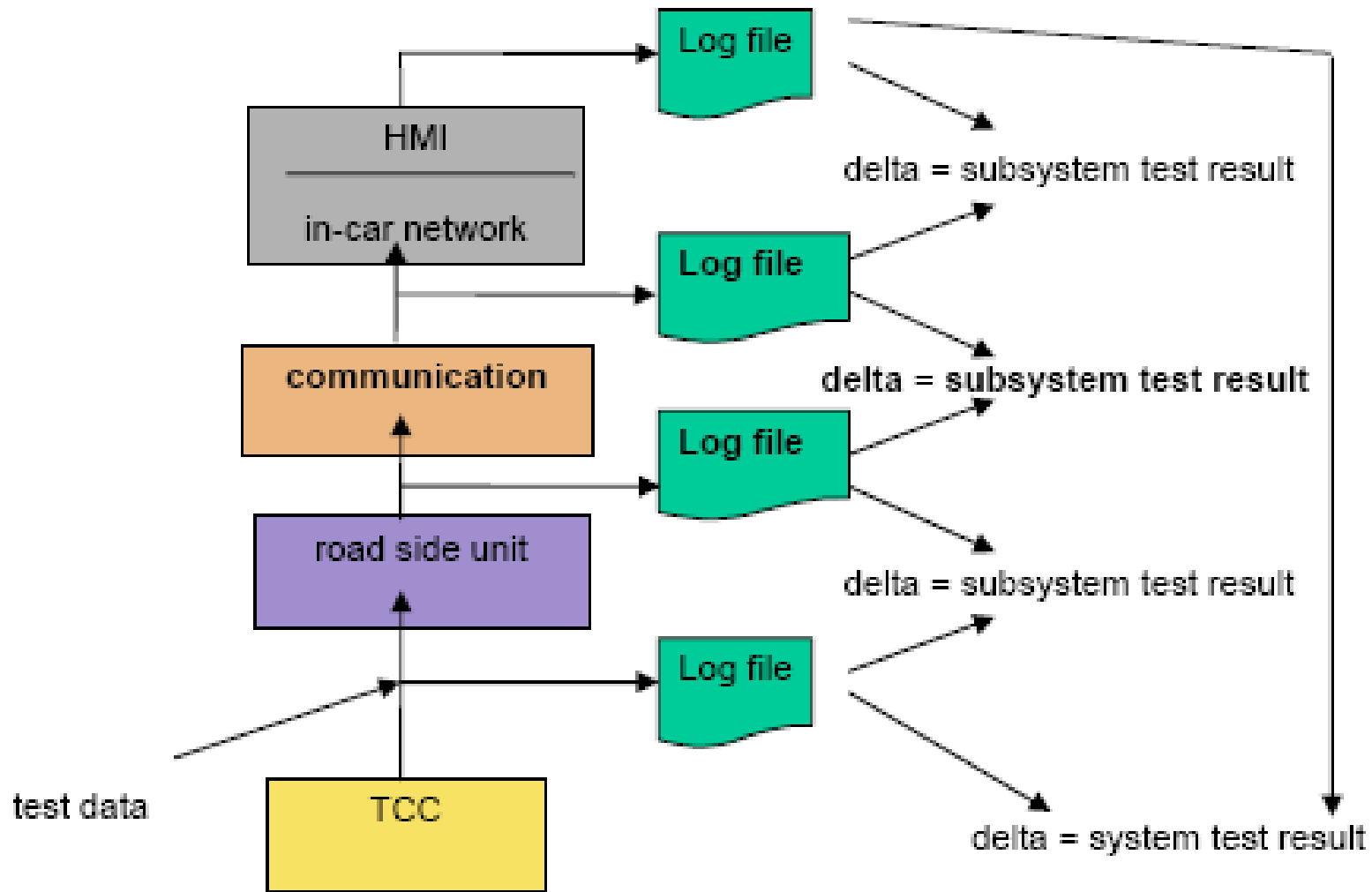
AUSTRIAN INSTITUTE
OF TECHNOLOGY

TEST DATABASE
(Test Cases,
Test Scripts,
Test Logs,
Test Reports)

System Integration Test



Subsystem Integration Test



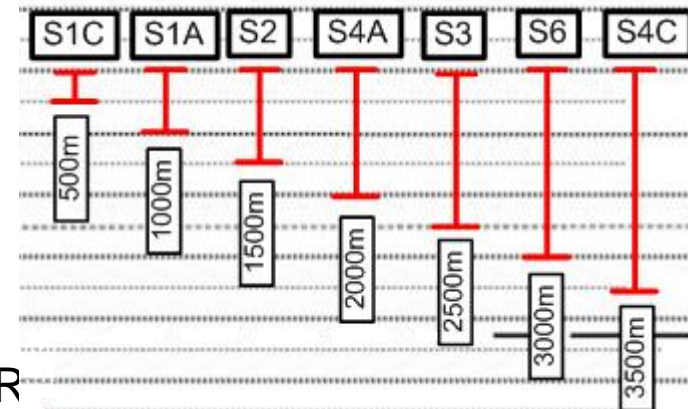


Acceptance Test Site 1 / IT

- Rarely real messages („motorway works too good“) => Mostly simulated ones
- Tested services: S1—S7
- Several issues regarding roadside infrastructure and Car PC fixed
- **Very good performance, key requirements fulfilled**
- Open issues: several on RSU logging, esp. when many services are transferred at high speed, only once end location 41 m too late (**better than 97% ✓**)
- **Also very demanding test cases passed,**

e.g. the **Pan flute test:**

- a series of services
- with different priorities
- starting at the same position
- ending one by one
- ordered by decreasing priorities.



- Final acceptance test on test stretch Trento-R
- Result: Very good performance w. r. t. key requirements. Site1/IT **Pass.**



Validation+Acceptance Test Site2

- Tests:
 - 1 drive on original test stretch (Rotterdam – Antwerp) and
 - 3 consecutive drives on extension Leidschendam - Rotterdam Airport
 - 1 additional drive Leidschendam - Rotterdam Airport with special test cases
- APC stable, services mostly displayed in a reasonable manner.
- Precision of service display location correct in all cases.
- GPRS connect with the COOPERS Service Center worked also in Belgium. But no service close to the border defined (S8 – int. service handover)
- Six test issues observed
- Result: Sufficient functionality of services 1-6 and 13 with GPRS has been proven with several issues resolved.



WP 5000 Next Validation Steps

- **Site 3 / Berlin**
 - In contact with partners
 - Acceptance test probably Feb. 2010
- **Site 4 / France**
 - In contact with partners
 - Acceptance test February 2010
- **Site 1 / Bavaria:**
 - Tests February 2010, details under discussion
- **Final evaluation and recommendations in preparation**



NAV-CAR Project facts

**NAV-CAR - Improved Navigation in
challenging Areas by Robust Positioning**

Complementary national project to COOPERS

(6th Call asap programme (Austrian Space Application Programme –
Galileo Simulation),

Duration: 1. July 2009 – 31.12.2010

Partners: AIT (two divisions/organizations), Brimatech, EFKON;
subcontracting pwp-systems, support from ASFINAG, Autostrada del
Brennero, AustriaTech/COOPERS

- NAV-CAR aims at making car navigation more robust while at the same time providing more accurate and precise information compared to existing navigation solutions.
- Focus lies on more accurate and robust positioning and map referencing in order to be able to provide lane specific positioning information for traffic and navigation information services.





Project facts

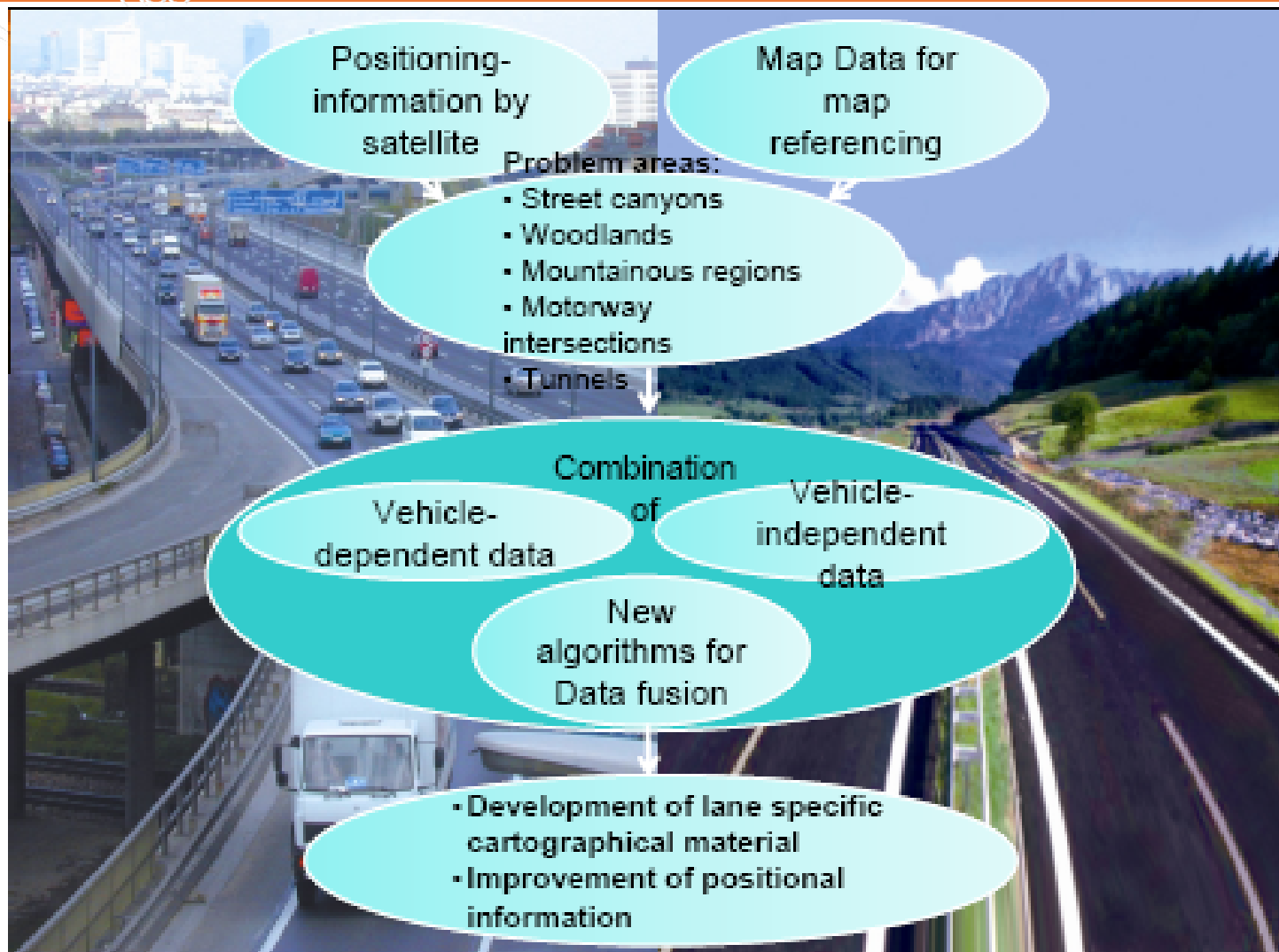


NAV-CAR: Examples for lane-specific services

- **Road Surface Examination**
 - Surface Analysis (Exact Positioning of Road Defects),
 - Optimization of Road Surface Examination (road condition such as temperature) for gritters
- **Generating and Updating of Maps**
- **Lane-specific Traffic Light Control / Regulation**
- **Distance Measurement between cars (driving behaviour, accident analysis, micro-traffic models)**
- **Traffic Flow Management beyond COOPERS**
 - More accurate lane banning, lane keeping, auxiliary lane utilization
 - Lane-specific Speed Profiles
 - Tracking and warning (wrong-way drivers)
- **Optimization and tracking of maintenance work, winter services etc.**
- **Interesting Services for Emergency Services (e-Call)**
 - exact accident localisation (time-efficient action planning)
 - exact localisation of the caller
 - accurate route calculation



NAV-CAR

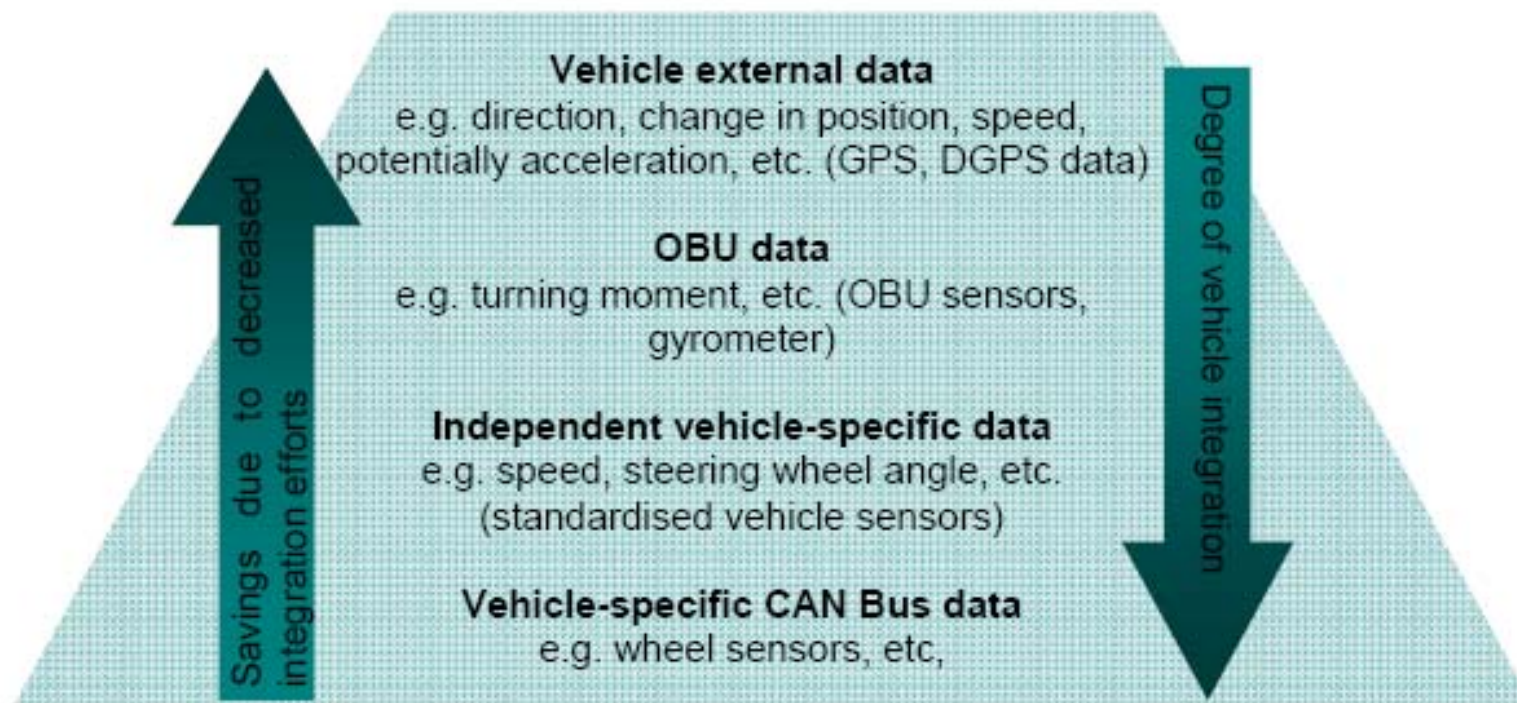




NAV-CAR



Objective is to improve the OBU performance by means of data that require no or minor vehicle integration (vehicle independent data), such as acceleration sensors, positioning via WLAN, Infrared, GPS and UMTS cells, as compared to performance utilizing vehicle-specific data.





Further Information:



DI. Erwin Schoitsch

AIT Austrian Institute of Technology

+43 664 6207700

Erwin.schoitsch@ait.ac.at



Alexander Frötscher (co-ordinator)

Austria Tech

+43 1 26 33 444 - 64

alexander.froetscher@austriatech.org

www.coopers-ip.eu



www.prose-project.eu

Co-operation ETSI – ProSE (EU-FP7 ARTEMIS
Support Action for *Promotion of Standardization
for Embedded Systems*, contract # 224213)



ETSI, 2010-02-12

